

THE INTERPLAY OF BOTANISTS AND
POTENTILLA ROBBINSIANA: DISCOVERY,
SYSTEMATICS, COLLECTION, AND
STEWARDSHIP OF A RARE SPECIES

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ABSTRACT

Potentilla robbinsiana Oakes ex Rydb. was first collected ca. 1824 by Thomas Nuttall on Monroe Flats in the Presidential Range of New Hampshire. Partly because the plant has always been rare, botanists have searched for, collected, studied, hiked past, propagated, and protected it. This paper documents botanical exploration, taxonomic interpretations, and historical status of *P. robbinsiana* populations. In the last 160 years, human interplay with *P. robbinsiana* has gone through roughly three phases of intense interest: discovery, collection and stewardship. In each period, human perceptions of, and reactions to, the rarity of this species have changed. The most significant human impact on the Monroe Flats plants was trail disturbance and zealous herbarium collection in the late 1800's. Even the cumulative removal of over 850 plants (equivalent to approximately half of the population) has not permanently affected the population size or distribution on Monroe Flats. Active conservation over the past 75 years has supplemented the natural resilience of the species. A second tiny and imperiled population on Franconia Ridge, discovered by Edward Tuckerman, Jr. ca. 1840, has never drawn much management or botanical interest.

Key Words: *Potentilla robbinsiana*, historical ecology, conservation biology, endangered species, alpine zone, herbarium collections, Thomas Nuttall, William Oakes, Edward Tuckerman, Jr., White Mountains, New Hampshire

INTRODUCTION

Potentilla robbinsiana Oakes ex Rydb. (dwarf cinquefoil), the only plant species endemic to the White Mountains of New Hampshire, is singularly relict. It has persisted—perhaps at only two spots—since the alpine region was separated from the arctic some 9000 years ago (Spear, 1989). The nearest related species, *Potentilla hyparctica* Malte (Löve and Löve, 1965, 1966), occurs 600 km to the north at four sites in the western Shickshock Mountains of the Gaspé, Québec, Canada. The latter alpine plants are themselves equally isolated, 800 km from arctic populations (Hultén, 1968).

Native *Potentilla robbinsiana* presently grows in two restricted locations. The primary population of 1500–2000 flowering individuals occurs on Monroe Flats (Sargent's Purchase, Coos

County), 2 km southwest of the summit of Mount Washington and just south of Lakes of the Clouds. The area (1548 m elevation) is at the head of Oakes Gulf, just above treeline in the col between Mt. Monroe to the west and the south shoulder (Bigelow Lawn) of Mount Washington to the east. Here a low dome of till supports the most well-developed turf-banked terraces in the White Mountains. Most *P. robbinsiana* plants grow on the periphery of this knoll, primarily southeast of the barren crown. Some 30 km to the west, a second tiny population is found in the small alpine zone on Franconia Ridge (Franconia, Grafton County). This station of less than ten individuals is on a west-facing cliff (1460 m elevation) just south of Mt. Lincoln.

Potentilla robbinsiana was listed as federally endangered in 1980 (Cook, 1980). Although a "classic rarity," with both highly restricted geographic range and habitat specificity (Rabinowitz, 1981), the species is locally abundant at one locality and occurs in a distinctly different habitat at a second (Graber, 1980; Fitzgerald et al., 1990). Further dimensions of *P. robbinsiana*'s rarity include close human contact and taxonomic ambiguity. Despite recent population studies and political concern (Steele, 1964; Graber, 1980; Graber and Brewer, 1985; Fitzgerald et al., 1990), the botanical history of *P. robbinsiana* has been little known except for herbarium collections.

Herbarium Collections

Herbaria provide an unparalleled database on historic collection locations, collector activity, and taxonomic treatment. Of the 96 public herbaria contacted for information on *Potentilla robbinsiana* and its synonyms, 59% (57) had some plant material (Table 1). Specimens are found today in herbaria from St. Johnsbury, Vermont to Grahamstown, South Africa. Herbaria typically contain massive collections from the late 19th century. Although large New England herbaria have traditionally been tapped for local information, they contain less than 20% of the more than 235 existing sheets of *P. robbinsiana*. Previous studies using 21 to 50 sheets (Pease, 1924; Steele, 1964; Graber, 1980; New Hampshire Natural Heritage Inventory files) have given a limited picture of collection history. Significantly, most early and most Franconia collections are found in European herbaria.

The extensive herbarium material represents one of the most

Table 1. Number of separately labelled collections of *Potentilla robbinsiana* known from various public herbaria.

Location Herbaria	Monroe Flats			Fran- conia	Total (#)	Sheets (#)	Plants (#)
	1824- 47	1858- 1909	1916- 83	1840- 1915			
Large New England (GH, NEBC, HNH, NHA, VT)	8	49	1	2	60	42	220
Other New England (in 10 of 15 checked)	9	27	6	2	44	41	135
Large American (US, NY, PH, F, MO, CAN)	5	54	3	3	65	56	210
Other American (in 19/42)	2	57	7	1	67	61	201
Outside N. America (in 17/28)	28	6	4	5	43	35	113
All known ($n = 57/96$)	52	193	21	13	279	235	879

intensive collections of a single species yet documented. It is even more impressive considering most collections are from a single site. Herbaria contain 279 separate labels of 879 individual plants collected from ca. 1824 to 1983 (Table 1). Forty-eight collectors are represented, but over half of the plants were taken by only six botanists (W. Oakes—20 sheets; E. Tuckerman, Jr.—23 sheets; C. G. Pringle—28 sheets; Faxon brothers—17 sheets; W. W. Eggleston—55 sheets; and E. F. Williams—13 sheets). In addition, many specimens were not deposited (e.g., are in personal herbaria, used for transplants or cultivation, or lost). Since the 846 known specimens collected at Monroe Flats represent a minimum number, it is probable that collectors have removed well over a thousand plants.

DISCOVERY

The dates, locations, nomenclature, and even origin of most early reports of *Potentilla robbinsiana* are unclear. Conflicting accounts credit at least five botanists, in addition to Robbins, with its discovery. The original publication of *Potentilla robbinsiana* cites material from "Nuttall! Oakes! Tuckerman!" (Torrey and Gray, 1840). While Thomas Nuttall apparently collected it in 1824, the earliest dated herbarium specimen (UPS) is from William Oakes and Charles Pickering in 1825. In 1840, Edward

Tuckerman, Jr. wrote that “Mr. Oakes who discovered it at this station had it only in fr[uit]” (CuCo 3/1840). In a letter written in October 1840, Tuckerman acknowledged that both Nuttall and Oakes “had only previously found the plant,” but intriguingly added that “Mr. Greene had also found it” (QK). Benjamin D. Greene was at Lakes of the Clouds in 1823 when he found at least two other rare species (Pease, 1917, 1964), but *P. robbinsiana* is notably absent from Greene’s collections cited in Bigelow (1824). Without a specimen, field notes or substantiating account, any reports before 1824 are uncertain.

Thomas Nuttall

Either Asa Gray or John Torrey had “seen an authentic specimen” of *Potentilla robbinsiana* from Nuttall. Retaining chronological priority, they listed Nuttall first (Torrey and Gray, 1840). Although no dated material survives, Thomas Nuttall almost certainly collected *Potentilla robbinsiana* in August 1824. Notes on herbarium sheets of *P. robbinsiana* indicate that in September 1839, Nuttall told Edward Tuckerman, Jr., “that he also found it” (UPS, QK). Charles Pickering (1879) even wrote that in 1824 “Nuttall [was] visiting the White mountains, meeting with . . . on the alpine portion of the mountains, *Potentilla frigida* [= *P. robbinsiana*], *Gnaphalium supinum* . . . and *Salix repens*.” Nuttall made only one trip to the White Mountains, obviously collecting alpine plants in August 1824 when he signed Crawford’s register (CrPa, 12/8/1824; Pease, 1918; Graustein, 1967). A sheet of *S. uva-ursi* (= “*S. repens*”) from Nuttall’s herbarium (BM) is indeed labeled “White Mts., 1824. . .” There are no collections of *P. robbinsiana* now in Nuttall’s herbarium, but one undated specimen of “*Potentilla brauniana* Hoppe” from the “White Mountains” attributed to Nuttall is in Hooker’s herbarium at Kew. This sheet (κ) thus appears to be part of Nuttall’s original collection and the earliest surviving collection of *Potentilla robbinsiana*.

William Oakes was competitive and thus skeptical of Nuttall’s rarities. He referred to *Gnaphalium supinum* as “Nuttall’s doubtful” species (OaCoGH, 4/1829) and summarily dismissed Nuttall’s *Carex atrata* as variously misidentified (e.g., TuPa, 8/1839). Apparently in reaction to Torrey’s publication acknowledging Nuttall’s collections, Oakes wrote to Torrey that Nuttall had told him that Nuttall “. . . did not find them [*Potentilla minima* and *Arnica mollis*] himself.” Oakes asserted that “Nuttall’s specimens

. . . were given him . . . by Dr. Holmes of Maine, who was posterior to P[ickering] and myself . . ." (ToCo, 4/1841). In fact, Ezekiel Holmes' only known trip to Monroe Flats was on 27 July 1825, when he "coasted along by blue pond and Mt. Monroe . . ." in the company of Oakes (CrPa, 7/1825). Confusingly Oakes must have been responsible for any collection by the young Holmes. It seems likely that Oakes' self-serving story was simply trying to obfuscate the discovery of *P. robbinsiana* by the reticent Nuttall (cf. Graustein, 1964, 1967).

William Oakes

The major early collections of *Potentilla robbinsiana* are attributed to William Oakes. During several weeks in 1825 Oakes made "tours around the mountains" collecting "some rare [plants] . . . not to be found elsewhere in America" (Crawford, 1846). Oakes, together with Charles Pickering, made collections of a dozen new alpine species (Oakes, 1841; Pickering, 1879; Pease, 1964). They apparently found *P. robbinsiana* at this time, as the only dated herbarium sheet was collected by "Pickering & Oakes, July 1825" (UPS).

In 1827 both Oakes and Pickering returned to Ethan Crawford's house (CrPa, 18-28/7/1827). Oakes collected *Potentilla robbinsiana* in July 1827, as he wrote to John Torrey that he had "just returned from the White mountains and had found 3 more flowering specimens of the little *Potentilla* . . . [with] several hundred specimens observed" (ToCo, 8/1827). In addition, Tuckerman stated (UPS) that Oakes and Pickering found *P. robbinsiana* in 1827 and a collection (QK) attributed to Pickering alone must be from either 1825 or 1827 (Pickering, 1879; Pease, 1964). In April 1828, Oakes sent Torrey one flowering specimen of "*Potentilla frigida*" (ToCo, 15/4/1828). A single specimen in a small packet labeled "*Potentilla frigida*, Vill., Wh. Mts., Oakes" (NY) fits this description and is apparently contemporary, albeit not obtained directly from Torrey's herbarium.

Other Early Collections

Before its first published mention in 1840, *Potentilla robbinsiana* was known by many. In 1829, Ethan Crawford helped "some

botanists from Boston . . . [collect] an assortment . . . [of] delicate mountain flowers” to send to Europe (Crawford, 1846). These plants probably included *P. robbinsiana* (PR) and the type of *Prenanthes bootii* (G; Pease, 1917; Graustein, 1964) collected by J. W. Boott in 1829, as well as the *P. robbinsiana* (PR) attributed to Francis Boott’s herbarium (Lehmann, 1851). Oakes and Tuckerman both made multiple collections of *P. robbinsiana*, and at least four other botanists had herbarium collections by 1840.

Some of Oakes’ collections come from his later explorations, 1843–47 (Pease, 1964). For example, two fruiting specimens, “Legit Oakes” (NY), are from the Princeton (perhaps Torrey’s) herbarium, and the nomenclature “*Potentilla minima*” dates them in the 1840’s. Oakes certainly got *P. robbinsiana* in 1843 when he collected all known rare species in the White Mountains (Pease, 1917). In 1844, Oakes first discovered *Euphrasia oakesii* at an unknown location, but probably on Monroe Flats where it has always grown together with *P. robbinsiana* (Oakes, 1847; Robinson, 1901).

Despite contemporary knowledge of Nuttall’s, Oakes’ and Boott’s early collections, they were later overlooked. For example, Asa Gray (1867) only cited collections attributed to “Robbins, Tuckerman, & c. . . .” Following Gray, researchers (e.g., Allen, 1888; Rydberg, 1898; Fernald, 1950; Graber, 1980; Lanier and Hill, 1983) have erroneously believed that James W. Robbins discovered *Potentilla robbinsiana*. In 1829 William Oakes, the source for the specific name, sent Robbins on a highly successful collecting trip to the White Mountains (Oakes, 1841; Pease, 1917). Although Oakes had mailed him a specimen of *P. robbinsiana* in April 1829 (OaCoGH, 4/1829) and “directed him exactly . . . [to] the locality of the rarer plants[,] . . . Robbins found none of [them]” (TuCo, 4/1841). Neither herbarium sheets nor any report of *P. robbinsiana* by Robbins has been found. Ironically, it appears that Robbins was one of the few botanists who visited the area before 1830 who did not collect his namesake. Furthermore, the possessive form of the colloquial name, Robbins’ (sic) cinquefoil, is a misnomer. The Latin adjectival suffix (-iana) implies that Robbins was simply being complimented (Stern, 1966). Although he admittedly did “not care much for the Lindley rule” (TuCo, 12/1843), Oakes clearly recognized discoverers with a genitive (-ii suffix) specific epithet.

Locale of First Collections

Until 1840, *Potentilla robbinsiana*'s location was "obscure & out of the way of travellers" (CuCo 3/1840). No *P. robbinsiana* collected before 1839 bears an exact location, but circumstantial evidence indicates that all came from Monroe Flats. Early explorers (e.g., Bigelow and F. Boott in 1816) used an eastern route up the White Mountains (OaCoAAS, 10/1844), and none reported *P. robbinsiana*. Collections apparently started only after the first Crawford Path was cleared on the west side in 1819 (Crawford, 1846). This route passed near Mt. Monroe, but after 1821 most trips up Mount Washington were made over a more northerly second Crawford Path (Waterman and Waterman, 1989). The latter route was a "poor one for botanizing" (Southwick, 1842), and botanists obviously explored interesting areas near "E. A. Crawford's old path" (Oakes, 1841). Both Nuttall and Oakes visited the Monroe region well before a bridle path first crossed Monroe Flats ca. 1840 (Waterman and Waterman, 1989). In 1824 Nuttall found *Gnaphalium supinum* in a "dry ravine of the Ammonoosuck" (Torrey and Gray, 1840), conceivably the edge of Monroe Flats. Similarly, Nuttall's collection of the rare *Carex atrata* (Beck, 1833) is consistent with a site near Oakes Gulf. In 1825, Oakes first visited the "fertile locality" of Oakes Gulf (Pease, 1917). All of Oakes' sheets in 14 herbaria are simply from "Alpine Region, White Mountains, New Hampshire," but Tuckerman definitively states that Oakes found *P. robbinsiana* at only one station (CuCo 3/1840; QK). Significantly, Tuckerman wrote that *P. robbinsiana* was found "by Mr Oakes & Dr. Pickering at the same station where I found it" (UPS). This location, unquestionably Monroe Flats, was the "peculiar home of the alpine cinquefoil" (Tuckerman, 1860).

The flora of the Franconia Range was "very poor" (OaCoAAS, 10/1844), but *Potentilla robbinsiana* was found there at first exploration. Although the new site was never publicized, Edward Tuckerman, Jr. collected five undated herbarium sheets (7 specimens) from the "Franconia Mountains" (NY, K, UPS, E). One sheet (UPS) elucidates the location as "Great Haystack" where Tuckerman first recorded alpine species in 1840 (TuCo, 10/1840; Tuckerman, 1843). Tuckerman was distributing *P. robbinsiana* in Europe in 1841-42 where most of his Franconia specimens are now found. In the late summer of 1844, Tuckerman returned to

Franconia Ridge for a “very thorough exploration of the Gt. Haystack.” He then stated that “*Potentilla (minima)* is limited to the spot where I first found it & here only grows *Polygonum vivip.* . . .” (OaCoAAS, 10/1844). Thus his Franconia discovery was presumably ca. 1840 from a single station. Interestingly, Tuckerman’s collection of *Polygonum viviparum* (NY) was the only time this species has ever been recorded from Franconia.

SYSTEMATICS

Early Taxonomic Uncertainty

Early American botanists were initially confused about the taxon to which their alpine *Potentilla* belonged. Without an American counterpart, most early collections of the dwarf *Potentilla* from the White Mountains were compared to various European taxa. For example, Nuttall’s ca. 1824 specimen (κ) is labeled “*P. Brauniana*”; F. Boott’s 1829 plant (PR; Lehmann, 1851) has the undeterminate “*Pot. sp.*” annotated to *P. nivea?*; and J. W. Boott’s 1829 companion collection (PR) is identified as *P. villosa*. While there was some early agreement that the plants belonged to *P. brauniana*, Oakes initially decided it belonged to another European alpine species. In 1827, Oakes simply called it the “little *Potentilla*” and stated that the specific taxon “cannot be settled until European botanists will make up their minds” (ToCo, 8/1827). Soon afterward, Oakes called it “*Potentilla frigida*” when he sent specimens to John Torrey (ToCo, 4/1828). Ironically, Torrey’s reply asked if Oakes was “convinced that this cannot be the species we first considered it (*P. nana* Lehm.)” (OaCoAAS, 4/1828). Prophetically, Torrey’s early determination placed it with the then little known arctic species to which it is now considered most closely related.

Early collectors had trouble recognizing the species without a name or description, yet taxonomists were dependent on their collections. For instance, Tuckerman was still unaware of *Potentilla robbinsiana* 15 years after its discovery and he failed to recognize it as he first crossed Monroe Flats. In June 1839 he collected a “Pl[anta] incog[nita] near snow Mt. Monroe” (TuPa, 24/6/1839). Two days later, he refined his identification of the unknown plant to “*Planta Rosacearum.*” Later that summer, Tuckerman had identified the rose’s genus (TuPa, 8/1839), and

specifically discussed the *Potentilla* collections and taxonomy with both Oakes and Nuttall. After an evening talk with Oakes, Tuckerman recorded their uncertainty: "*Potentilla* --- Mr Oakes doubtful about" (TuPa, 2/8/1839). Oakes, nevertheless, must have developed the idea of a distinct species, as two weeks later Tuckerman annotated a specimen collected earlier that summer: "*Potentilla Robbinsiana* Oakes! MSS." (NEBC). In September 1839, Nuttall also told Tuckerman that he still "considered it distance [sic] from *P. Brauniana* or *P. verna* or *nivea*" (UPS).

Although Oakes coined the name "*Robbinsiana*," he never published a description and apparently only communicated the name privately. The first published description of the taxon listed "*Potentilla Robbinsiana*, Oakes! mss." as a synonym for an unnamed variety of the species *P. minima* (Torrey and Gray, 1840). Significantly, one 1825 collection by Oakes has an original label with the same nomenclature: "*Potentilla Robbinsiana* Oakes MSS." (UPS). All Oakes' other specimens or manuscript material referring to "*Robbinsiana*" have apparently been relabeled or lost. Confusingly, most of Oakes' herbarium sheets have printed labels with *Potentilla minima* and *P. Robbinsii* (sic) as a synonym. These labels, however, were added by Asa Gray after Oakes' death in 1848 (Gray, 1849). They were part of sets of "most of the rarer plants found in New England" which were sold (at \$20 per 500 species) accounting for the wide distribution of Oakes' herbarium. Significantly, Oakes seldom, if ever, wrote the name "*Robbinsiana*" himself, rather choosing "*frigida*" on both surviving herbarium material and correspondence before 1840 (e.g., NY; ToCo, 3/4/1828; OaCoGH, 4/1829). After Torrey and Gray submerged *P. Robbinsiana* under *P. minima*, Oakes changed his designation and referred to the species as "*Potentilla minima*" (e.g., ToCo, 4/1841; TuCo, 12/1843). Curiously, even after receiving credit for the species name *Robbinsiana*, Oakes rejected it.

Taxonomic Revision

The long lack of recognition, due in part to confused taxonomy, was finally settled by Asa Gray. Working on the Roseaceae for Torrey's *Flora of North America* in the 1830's, Gray examined *Potentilla* material, including Lehmann's herbarium (GrCo, 10/1839; Torrey and Gray, 1840). Torrey and Gray (1840) decided that the White Mountains species "agrees well with the character

of *P. minima*" Haller, the accepted synonym of *Potentilla brauniana* Hoppe (Koch, 1837). They relegated "*P. Robbinsiana*" to a variety (Torrey and Gray, 1840). Interestingly, Gray only saw plants in the field in September 1842, while on a trip with Tuckerman (GH, OXF). The first edition of Gray's Manual (1848) continued to recognize *P. minima* with the short-stemmed, small-flowered American variety. Although *Potentilla* expert Lehmann (1851) concurred exactly with this designation, Gray (1856) later transferred the taxon to *P. frigida* Villars. After being accepted as a variety of various European species for over 70 years, *P. robbinsiana* was validly given full species status by Rydberg (1896). Others (e.g., Britton and Brown, 1897; Rydberg, 1898; Wolf, 1908; Robinson and Fernald, 1908) concurred with this determination.

The genus *Potentilla* is known for its "devilish combination of apomixis, hybridization, and morphological plasticity" (Polunin, 1959). Due in part to the obscure evolutionary history of this "anomalous species" (Fernald, 1950), the taxonomic status of *P. robbinsiana* is still unclear (e.g., Fernald, 1931; Löve and Löve, 1965, 1966). One chromosome count from Monroe Flats showed an odd number polyploid $2n = 49$, which would indicate an obligate apomict (Löve and Löve, 1966). *Potentilla robbinsiana* is indeed agamospermous (T. D. Lee, pers. comm.). Although Löve and Löve (1966) concluded that *P. robbinsiana* "is apparently an apomictic segregate of *Potentilla hyparctica*," the taxon could also be a hybrid conserved by apomixis (Steele, 1964). *Potentilla hyparctica* itself is not well defined, but is typically $2n = 42$ (Malte, 1934; Löve and Löve, 1965; Dansereau and Steiner, 1956; Fernald, 1943; Moore, 1982). A distinct ancient hybrid between *P. hyparctica* and a $2n = 56$ taxon (known in other arctic species in the genus) producing the $2n = 49$ Monroe Flats' plant seems plausible. While being related to *P. hyparctica* (Löve and Löve, 1965, 1966; Crow, 1982), this hybrid would explain the enigmatic nature of *P. robbinsiana*.

Potentilla robbinsiana is morphologically distinctive, probably a direct result of its limited genetic variability. For example, flowering stem lengths of plants from the White Mountains overlap only slightly with those of *P. hyparctica* (Table 2). Even alpine *P. hyparctica* from the Gaspé can be easily distinguished from the White Mountain population (Fernald, 1950; D. Marris, MT herbarium note 1972). When grown in the greenhouse, however, Monroe Flats plants take on some of the characteristics of their

Table 2. Measurements of fruiting stem length from late-July and August herbarium collections of *Potentilla* from the White Mountains, New Hampshire, the mountains of the Gaspé and the low arctic in Québec, Canada.

Location/ Collection	Plants measured (<i>n</i>)	Fruiting stem length (mm)		
		Mean*	±SD	Range
Monroe Flats				
Nuttall ca. 1824	1	18.10		18.1
Oakes pre-1848	19	16.74b	5.61	7.2-26.5
Tuckerman ca. 1840	11	22.91a	6.42	13.1-33.1
Since 1880	194	22.74a	5.88	6.3-39.6
Franconia				
Tuckerman ca. 1840	6	45.38c	11.65	26.0-57.7
North 1897-1908	2	18.50	8.34	12.6-24.4
Fernald 1915	17	20.30a	4.09	13.1-26.2
Québec (<i>P. hyparctica</i>)				
Gaspé	37	69.53d	22.95	35.1-103.7
Ungava	24	68.26d	20.78	31.8-123.7

* Different letters indicate a significant (*t*-test, $P < .05$) difference between means.

arctic relatives (Löve and Löve, 1965; K. D. Kimball, pers. comm.). Nevertheless, the geographic isolation, morphological differences, narrow ecological range and asexual breeding system all argue for the continued species-level separation of *P. robbinsiana*.

Collections from the Franconia Range in the 1840's are different from either Monroe Flats or recent Franconia plants. Their habitat, presumably damp mats with *Polygonum*, was also odd. Tuckerman labeled the specimens "*forma aestivalis*" and on one sheet indicated the character of "*pedunc. elongatis*" (NY). Long fruiting stems (unfortunately there are no flowers), place them between *P. robbinsiana* and *P. hyparctica* (Table 2). These remarkably different plants perhaps represented genetically distinct stock.

PRESENT DISTRIBUTION

Population on Monroe Flats

In 1839 *Potentilla robbinsiana* was found on a "stony alpine moor on Mount Monroe" (TuPa, 6/1839; Tuckerman, 1843). Its distribution was then described as "very limited & very [struck out] obscure" (CuCo 3/1840). Since 1865, herbarium records

have cited it as specifically along the Crawford Path (GH). The original Crawford Path skirted the southeast edge of the knoll within the upper edge of the present range of *P. robbinsiana* (Figure 1). Reminiscences from the 1960's also place the majority of the *P. robbinsiana* plants on the southeast side of the knoll and figuratively "moving toward" the outcrop (C. Harris, pers. comm.). A survey of this main population in 1967 revealed a distribution east of the trail, very similar to the present range (W. N. Tiffney, Jr. and B. K. Fowler, pers. comm.). The .11 ha area occupied by the main population has changed little from 1973 to the present (Graber, 1980; Graber and Brewer, 1985; Figure 1).

In addition to the main congregation of *Potentilla robbinsiana* near the rock outcrop at the south edge of knoll, there has been a handful of small outlier populations on Monroe Flats (Figure 1). These sub-populations, scattered over the .85 ha barren area, are in marginal habitats and may be ephemeral. Currently, three peripheral populations, all "discovered" since 1983, are scattered to the north of the main population. In 1985, these outliers had a total of 15 flowering individuals; this number decreased to nine plants in 1992.

For over 40 years, a notable outlier population was found west of the post-1918 Crawford Path. About 1900, *Potentilla robbinsiana* grew there "in dry stony soil" together with *Euphrasia oakesii* (Robinson, 1901). In 1946, Steele (herbarium notes) still found both species "on the southwestern side of a shaly hump." This *P. robbinsiana* sub-population contained a limited number of plants (i.e., 12 to 50 individuals as estimated by F. Steele, C. Harris, W. N. Tiffney, Jr.) and was last seen about 1969. Interestingly, the only extant colonies of *Euphrasia* are now east of the trail just beyond *Potentilla*'s range; apparently both of these species have been extirpated from the west side of Monroe Flats. Steele's often-quoted conclusion (e.g., Cook, 1980; Graber, 1980; Lanier and Hill, 1983) that *P. robbinsiana* now occupies one-fourth of its 1934 area is based on the disappearance of the restricted sub-population west of the trail (Steele, personal herbarium notes, 1977). A colony 30 m south of the outcrop similarly decreased from 40 individuals in 1973 (Graber and Brewer, 1985) to none in 1988. Overall, the small sub-populations seem prone to extirpation while the main population has remained viable for centuries.

In addition to native plants, there are currently several trans-

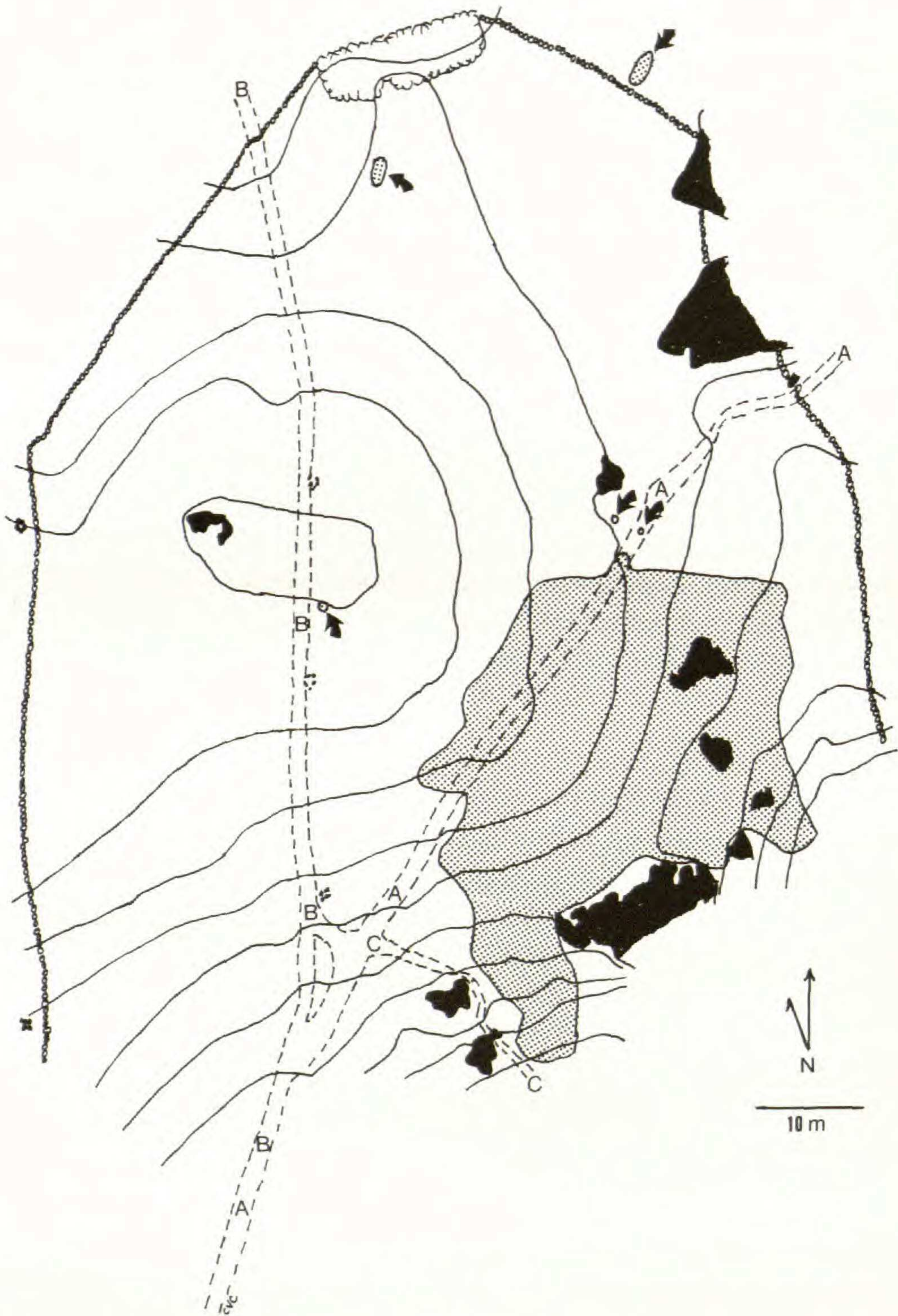


Figure 1. Map of Monroe Flats, Presidential Range, New Hampshire showing the current range of *Potentilla robbinsiana*. Shaded area is the extent of the main population of *P. robbinsiana* mapped in 1985; arrows indicate outlier sub-populations. One unmapped sub-population occurs 30 m south of the main population. Solid lines are contours in one-meter intervals below a datum at the high point of the knoll (ca. 1548 m). Dotted lines delimit the extent of the treadway

planted populations of *P. robbinsiana* established in the White Mountains. Three programs (i.e., Harris, 1964; Graber, 1974–85; AMC, 1986–89) have transplanted more than 500 individuals, grown from Monroe Flats stock, into at least six locations (i.e., Camel Patch, Oakes Gulf, top of Monroe Flats, Lakes Hut, Boott's Spur, North Lafayette).

Since the 1820's, *Potentilla robbinsiana* has been common on Monroe Flats. In August 1827, William Oakes observed "several hundred specimens" (ToCo, 8/1827). Considering its inconspicuous nature after flowering, Oakes' casual record is certainly a gross underestimate. Between 1824 and 1847, botanists removed more than 96 plants from the site, including at least 50 by Oakes himself. In several years at the turn of the century, hundreds of plants were collected at once. A minimum population of many hundreds must have been maintained as this heavy and sustained collecting occurred without comment or extirpation. In 1977, a casual estimate of the "population of ca. 300 plants" (NHA: *Crow #2449 & Hellquist*) was remarkably similar to that of 1827. Much of the population, however, was again overlooked as Graber (1980) had counted 1801 large plants in 1973. Some 1701 flowering plants were counted in 1992 (M. Iszard-Crowley, pers. comm.) and the population on Monroe Flats seems to have been relatively stable over the past 20 years (Graber and Brewer, 1985; Fitzgerald et al., 1990). For the last 165 years the population has certainly been in the hundreds, and probably had been in the thousands.

Population on Franconia Ridge

The first known Franconia *Potentilla robbinsiana* were near Mt. Lafayette. Tuckerman's 1840's collections were most likely from the accessible summit of "Great Haystack," the early name for Mt. Lafayette. On 10 July 1897 during an Appalachian Mountain Club (AMC) field meeting (Anon., 1898), Frederic Endicott collected a single *P. robbinsiana* from "near north summit of Mt. Lafayette" (GH). The third and last known collection was on 6

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of abandoned trails, specifically: A—the original Crawford Path (ca. 1840–1918); B—the Crawford Path (1915–83); and C—the Dry River Trail (ca. 1938–65). Large rocks and outcrops are solid. A scree wall built in 1983 to delimit the restricted area is shown as a chain.

July 1908 by an unknown "Hunt" on "Mt. Lafayette" (CONN). This collector was perhaps William S. Hunt, an amateur who collaborated with Endicott in producing a list of alpine plants collected on AMC trips (Fuller et al., 1907). The Mt. Lafayette station was apparently extant in 1908, but extirpated by 1915.

Since 1915, all *Potentilla robbinsiana* from Franconia have been found at a station well south of Mt. Lafayette. On 18 July 1915 during a weekend trip over Franconia Ridge, M. L. Fernald and his graduate student, F. J. Smiley, found *P. robbinsiana* on "damp gravel and crevices about the low north dome of Mt. Lincoln" (GH; FeCo, 8/1915). Fernald returned in August 1915 to scour the ridge, finding rare plants elsewhere, but *P. robbinsiana* was apparently restricted to the one site. On 13 June 1963, Fred Steele found *P. robbinsiana* still on Mt. Lincoln. Two plants, including one with 50 flowers which was the largest Steele had seen, were growing with dead moss "on sloping rock" or "sort of ledge" along the trail north of Mt. Lincoln (Steele, pers. comm.). Botanists, including Steele, saw three plants in July 1965 (Steele, personal herbarium notes), but were unable to locate any in the 1970's. On 24 June 1984, AMC hutman Rick Boyce, found two living *P. robbinsiana* when he "just happened to see a yellow flower" while hiking just south of Mt. Lincoln. The following year Charles Cogbill and Roger Collins found four additional flowering individuals in crevices on the cliff directly below these plants.

Sketchy records of *Potentilla robbinsiana* indicate several small historic populations scattered along Franconia Ridge. All Franconia reports total only 51 individuals. Their extremely limited numbers, spotty occurrence, and habitat on gravel, ledges, or cliffs, set them apart from those on Monroe Flats. Some 38 plants are known to have been collected from Franconia and 29 (57% of the plants ever known there) are from a single collection by M. L. Fernald (11725) in 1915. None has been collected since 1915. Only 13 separate flowering plants have been seen in thorough searches over the last 30 years (e.g., Steele, 1964; Crow, 1982; Cogbill, pers. obs.). The Franconia population was never large; its current (1991) population of five flowering individuals is imperiled at the known remaining station.

Discounted Locations

Several herbarium collections from Mt. Washington sites are mislabeled. Tuckerman's 1839 herbarium labels (UPS, MASS, NEBC)

read: "Mt. Washington, N.E. [sic] side of the Peak." Despite incorrect dates and directions on the labels, his notes are explicit that he collected from Monroe Flats, "S.E. [sic] of the peak" (TuPa, 6/1839) and "not elsewhere" (UPS). Beaudry's collection from "Mt. Washington: 7-mile post" on 26 July 1958 (MT) was also mislabeled. His co-collectors that day did not find it there, actually collecting *P. robbinsiana* only from Monroe Flats (A. Löve, pers. comm.; Louis-Marie, QFA field notes). Two odd collections from "Tuckerman's Ravine" (NEBC: no collector and no date, but a H. G. Jesup 1890's label) and "Alpine Garden" (BSN: collector J. H. Emerton, 1907) have no other substantiation. Some herbarium sheets have indefinite locations such as "alpine region, New England," "White Mountains," or "Mt. Washington"; all except those from Franconia apparently are from the single Monroe Flats site.

No verifiable record of *Potentilla robbinsiana* exists outside New Hampshire. Speculation about a Vermont site is based on a specimen (NEBC) labeled "Mansfield Mt. E.T." found in 1979 among Robbins's material. Considering the notation, it has been interpreted as an Edward Tuckerman collection. Interestingly, Tuckerman's only known trips to Mount Mansfield, Vermont were in 1839 and 1840, and his field notes explicitly indicate that he did not find *Potentilla* then (TuPa, 7/1839; 7/1840). Apparently the label is not in Tuckerman's hand and was written after 1842 (Oakes, 1842). This enigmatic collection credited to Vermont (e.g., Crow, 1982; Gleason and Cronquist, 1991) remains dubious. Recent references (e.g., Countryman, 1980; Graber, 1980; Gleason and Cronquist, 1991) to an unvouchered sighting on a Vermont mountain from 1970 are based on a misidentification of *P. norvegica* from Mt. Equinox (Graber and Brewer, 1985).

PERCEPTIONS AND REACTION TO RARITY

Discovery Era: *Potentilla minima* 1824-60

Much of the early botanical exploration of the White Mountains was driven by the search for rare alpine species, including several found near Monroe Flats (Tuckerman, 1843; Bigelow, 1824; Oakes, 1847; Pickering, 1879; Pease, 1917, 1964). By the 1840's, Oakes considered a couple of local species "approaching exhaustion," presumably due to over-collection of rarities (Pease, 1917). Significantly, *Potentilla minima* never received the same attention

as these other species and was not even listed as "rare" (Spaulding, 1855). Lack of prominence of this species was exemplified by the fact that no one took credit for its discovery and by the failure of anyone, especially Nuttall or Oakes, to publicize or publish any description.

Early interest in *Potentilla robbinsiana* was driven by taxonomic considerations. Collectors were uncertain what taxon they found and were selectively exchanging specimens and intelligence (e.g., OaCoAAS, 4/1828; TuPa, 8/1839; TuCo, 12/1843). Even Tuckerman's early collections must have been limited as he was very concerned over the loss of some of his "rare" flowering *P. robbinsii* (sic) specimens (CuCo, 3/1840; 9/1840) and indicated that "my specimens are exhausted" (QK, 10/1840). Oakes' and Tuckerman's extensive and widely dispersed collections from Monroe Flats were fundamental in taxonomic work. Once Gray determined that it was part of a European alpine species (Torrey and Gray, 1840), it was no longer a "new" species and collections and interest diminished. Its well-known location, albeit obscure and disjunct from the Alps, rendered the White Mountain *P. minima* less of a rarity (TuCo, 12/1843; Tuckerman, 1860).

Collection Era: *Potentilla frigida* 1860-1910

Following an increased public interest in natural history, vast botanical collections were made between 1860 and 1910 (Table 1). Completion of the carriage road to the summit of Mount Washington in 1861 gave convenient access to the long-known site at Monroe Flats. In June 1862, three collectors began an era of group collecting by taking 34 plants (17 sheets). During the collection peak of the Victorian era, botanists sought to document carefully the alpine flora by making regular collecting trips to Monroe Flats (Pease, 1917). For example, "in the last week of May [1878?]," Edwin Faxon climbed from Crawford Notch "to gather *Potentilla frigida* in flower in its alpine home, . . . the little plain by the ice-clad Lake of the Clouds" (Kennedy, 1900). Zealous botanists made mass collections on specific forays (e.g., 60 plants by 5 collectors on 5 June 1878; 59 plants on 15 August 1898; and 75 plants on 2 June 1903). In 1898 alone, 143 known individuals were collected. In all, some 73% of *P. robbinsiana* collections date from 1875 to 1909 with more than 403 individuals taken during just 9 years at the turn of the century. At its

maximum, collection pressure was significant, removing an equivalent of perhaps one-third of the present population in a decade.

In the late 1800's, botanists expressed little concern about *Potentilla frigida*. Monroe Flats continued to supply unrestricted collections as many sought rarities to expand their personal herbaria (e.g., Northrop and Northrop, 1910). The two most prolific collectors, Pringle in the 1870's and Eggleston in the 1890's, were even selling alpine plants, specifically including *P. robbinsiana*, to other collectors at 10 cents per sheet (Anon., 1878; EgPa, 1901). A few such as G. M. Allen (1888) recognized the "incursions of botanists," but he still "took but a tiny spray . . . [of *P. robbinsiana*] . . . and left the remainder of the plant."

The western edge of *Potentilla robbinsiana* habitat has historically been close to trails (Figure 1), in particular part of the original Crawford Path (ca. 1840–1918) and the Dry River Trail (ca. 1938–65). For over 150 years, collectors, horses, and hikers passed through the population on a cleared topographic treadway (Waterman and Waterman, 1989). Improvement of the Crawford "bridle" Path, trampling by its users, and easy access for collectors have arguably been the most significant human impact on the plants. Nevertheless, this trail section, abandoned in 1918, now supports a vigorous population of at least 71 flowering *P. robbinsiana*. Collecting and trail activities from 1840 to 1918 apparently did not permanently affect the population.

Stewardship Era: *Potentilla robbinsiana* 1910–83

In 1915 Fernald made the last mass collection of *Potentilla robbinsiana*, nearly eliminating the population on Franconia Ridge. This was Fernald's only collection of this species, and reflected earlier unrestricted practice. Significantly, only 21 collections consisting of 56 specimens have been made at Monroe Flats since 1910 (Table 1). There were at least 15 individual collectors, but many explicitly showed restraint. For example, despite long-term interest in the plant, S. K. Harris collected only 3 plants for herbaria (1927–30) and F. Steele collected only 5 single plants (personal herbarium, 1934–56). In contrast, botanists associated with field excursions of the International Botanical Congress in Montreal in 1959, despite being asked not to collect it (Löve and Löve, mimeographed field guide, 1959), made at least six collec-

tions (19 plants). In the past 30 years, only three sheets of single plants have been collected, all by researchers working on the plant. Recently, plants have been used for chromosome counts (COLO: Löve & Löve, 1962), greenhouse cultivation (A. Löve, pers. comm.), transplants (Harris, field notes, 1964: 6 plants), vouchers (NHA: Crow and Hellquist, 1977), and "collected accidentally during a survey of the population" (MSC: Brewer, 1983).

In the mid-1900's, an emerging stewardship ethic spread among botanists and the hiking community. The very restricted distribution of *Potentilla robbinsiana* was documented and it was considered "probably the rarest plant to be found on the Presidential Range" (Harris, 1930, 1941). Botanists told their colleagues the plant is "scarce . . . please do not collect!" (Löve and Löve, mimeographed field guide, 1959), and asked the public to "please help protect this rare plant" (Bliss, 1963). Responding to increased curiosity about the plant, Harris and others in the 1960's showed visitors the small population west of the trail, rather than disturb the main population (C. Harris, pers. comm.). The Dry River Trail was even rerouted by those (i.e., S. K. Harris, W. N. Tiffney) who were concerned about its effect on erosion and several rare species (C. Harris, pers. comm.). Although recent human trampling has been considered a crucial impact (Graber, 1980; Graber and Crow, 1982; Graber and Brewer, 1985), effects associated with the post-1918 Crawford Path are minor in contrast to those in the past.

Due to efforts by interested botanists (e.g., F. Steele, R. Graber, G. Crow), the species was determined to be federally endangered. Following a recovery plan, Monroe Flats was closed to access in 1983 (Lanier and Hill, 1983). After nearly 75 years of informally decreasing human pressure, the species was legally protected from disturbance or collection. Recent human activities have been directed toward augmenting populations through trail relocation, access restriction, population monitoring and transplant programs (Fitzgerald et al., 1990). After 160 years of human influence, *Potentilla robbinsiana* is still tied to human intervention in the management era.

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MANUSCRIPTS CITED

Citations to unpublished manuscripts are abbreviated:

- CrPa—Crawford's register, 1823–35, Lucy Crawford Papers, MS 626 (3), Dartmouth College Special Collections
 CuCo—letters: Tuckerman to Curtis 9/3/1840, 11/9/1840, Moses Ashley Curtis Papers, #199, Southern Historical Collection, University of North Carolina Library, Chapel Hill
 EgPa—printed sheet [1901], Box 1, folder 10, W. W. Eggleston papers, MS-28, Dartmouth College Special Collections
 FeCo—postcard: Smiley to Fernald, 15/8/1915, M. L. Fernald correspondence, Gray Herbarium
 GrCo—letter: Gray to Hooker, 13/10/1839, A. Gray correspondence, Gray Herbarium

- OaCoAAS—letters: Torrey to Oakes 24/4/1828, folder 18; and Tuckerman to Oakes 10/1844, folder 19; W. Oakes Correspondence, American Antiquarian Society
- OaCoGH—extracts of letters: Oakes to Robbins 4/1829, 24/7/1829; and Oakes to Torrey 9/6/1834, folder 31; Biog 2 Oa 4, Box W, W. Oakes correspondence, Gray Herbarium
- ToCo—letters: Oakes to Torrey: 3/8/1827, 3/4/1828, 15/4/1828, 3/4/1841; J. Torrey correspondence, New York Botanical Garden
- TuCo—letters: Oakes to Tuckerman: 16/4/1841, vol. 3; 30/12/1843, vol. 5; Torrey to Tuckerman, 8/10/1840, vol. 3; E. Tuckerman, Jr. correspondence, American Antiquarian Society
- TuPa—botanical journals, 1838–39, Box 1, folder 1a; 1840, Box 1, folder 1; Tuckerman Botanical Papers, Amherst College Archives

HERBARIUM RECORDS CITED

Citation of herbarium acronym (Holmgren et al., 1990) indicates data or quotations from material contained on labels, annotations, or notes attached to herbarium sheets from that herbarium.

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